The Principles And Application Of Translatory Cuspid Retraction

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INTRODUCTION

Cuspid retraction has always been a rather awkward phase in the treatment of an extraction case. Management of this tooth seems to dominate and other procedures must await their turn. As a student orthodontist I felt the need for a device which could initiate early retraction and would apply retraction force at between thirty to forty per cent of the distance along the root from the cervical line to the apex. After graduation and starting practice it was possible for me to apply the theory, establish design criteria, and make the inevitable series of experimental appliances to accomplish the objective. The design presented here was developed after several configurations had been tested and discarded. This particular configuration was used without change during the period when performance was obtained. As to be expected with any device of this type, several improved versions are being considered at this writing.

Most present methods of cuspid retraction involve the application of a force in the area of the crown. After the crown has been tipped back to the second bicuspid, another levelling problem presents itself and only after the root has been moved distally can the operator apply procedures for controlled anterior retraction. Many well-organized treatment techniques incorporate this crown-tipping procedure. While reviewing literature during preparation for this writing I found that Calvin S. Case was aware of the importance of translatory tooth movement and that he introduced this principle into his appliances.

Read before the Southern California component of the Angle Society, 1962.

THEORY

Translatory ("bodily") tooth movement requires a uniform pressure distribution over the root surface which will provide uniform resorption. If it were possible, the ideal way to obtain this situation would be to apply a single force at the center of resistance (Figure 1). The center of resistance can be described as the point at which a single force may be applied to be equivalent to a uniform pressure distribution in the PDM. Uniform pressure distribution would cause a free body to accelerate at a given rate in a given direction with no rotation about any axis. An equivalent force placed at the center of resistance would create the same motion. Since tooth movement is essentially a problem of statics, not that of kinetics or kinematics, the force system must satisfy the requirements of static equilibrium. If the retraction force were placed at the center of resistance this would be a simple force system of action and reaction. The reaction would be the uniform pressure distribution in the periodontal membrane which is equivalent to a force equal, opposite and coaxial with the applied force. The tooth would then be in equilibrium.

The retracting force, however, must be applied aside from the center of resistance (Figure 1). This creates a more complex problem in static equilibrium. The labial view indicates no

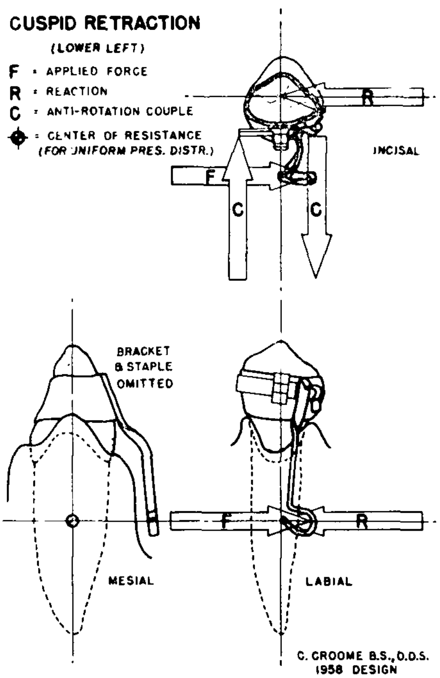

Fig. 1 System of Forces

forces out of balance. The applied force F and the reaction R, though not coaxial, are in the same plane; there is equilibrium in this view. The incisal view, however, is a different matter. The forces F and R do not oppose each other and this system of forces would tend to rotate the tooth in a counter clockwise direction. If an archwire is present, however, it can be made to bear against the mesial arm of the bracket and a ligating wire may be engaged to the distal staple. These two contact points create two further reactions (C) which are equal and opposite. Such a pair of forces is known as a couple. Since no other areas of restriction are available, this couple will develop a clockwise moment equal and opposite to the counter clockwise moment (or couple) created by forces F and R. This tooth is now in equilibrium, since for every force applied, there is an equal and opposite force and for every moment applied there is an equal and opposite moment.

In theory, at least, it would appear that this is the ideal appliance and system of forces. But problems do exist and, even if they cannot be eliminated, they must be identified and studied for the effect they will have on the ideal system of forces and, therefore, on the movement of the tooth. In many cases the arm cannot be made long enough to be opposite the center of resistance for the uniform pressure distribution. The center of resistance obligingly moves up to the same level as the applied force but it no longer represents a uniform pressure distribution over the root. The pressure is now greater at the cervical line than at the apex and the crown tends to go back faster than the apex. Another problem is present in the form of friction at the two contact points where the antirotation couple acts.

Friction is the resistance that is encountered when two solid surfaces slide or tend to slide over each other. Frictional resistance varies from a high between dry surfaces to a low when complete or viscous lubrication is present. There are two levels of friction under any given situation of lubrication. Static friction is the resistance at the state of impending motion. Sliding friction occurs when there is motion between the two surfaces.

The friction on the archwire appears to be a mixture of the above conditions. Viscosity of saliva varies throughout the day in the individual patient and is quite different from patient to patient. At first glance it might appear that this situation involves only static friction, but the tooth, archwire and the retraction appliance are constantly being disturbed by chewing, swallowing and other muscular gymnastics. Not only would the frictional resistance be difficult to measure but even with extensive data it would be difficult for the individual practitioner to calibrate a given patient. The clinical results bear out that considerable difference between patients does exist. Using known values of various types of friction involving steel against steel and making some broad assumptions on the presence of lubrication as well as muscular activity, the estimated friction force could vary anywhere from ten to fifty grams in the presence of a cuspid retraction force range from one hundred fifty to two hundred grams. The friction introduced may, however, be a blessing in disguise because in many cases the arm may not be long enough to approach the center of resistance for uniform pressure distribution. It would then seem desirable, if translatory motion is required, that a mesial force be applied at the crown. The frictional resistance is in the mesial direction and will reduce the tendency for the crown to be retracted faster than the root.

Storey and Smith, in their work of about ten years ago, indicated that to keep anchor unit disturbance to a minimum the cuspid retraction force should be at a range of two hundred to three hundred grams and that the cuspids stop moving when forces drop to sixty to one hundred fifteen grams. Burstone's recommended cuspid retraction forces vary from one hundred to two hundred grams depending upon the pain response and the mobility of the teeth.

Design Requirements

In order to approach the design problem intelligently it was necessary to compile a list of requirements for the cuspid retraction appliance. The more obvious of these were as follows:

1. Permit application of retraction forces very early in treatment.
2. Permit application of force as near to the center of resistance (for uniform pressure distribution) as practical.
3. Permit maintenance of almost the same magnitude of force during retraction (a low deflection rate).
4. Permit a high degree of control of cuspid position throughout retraction.
5. Permit use in the mouth with a minimum of soft tissue irritation.
6. Permit ease of fabrication on a production basis by the assistant or lab technician.
7. Permit disassembly to a normal bracket configuration without requiring band removal after the cuspid retraction has been accomplished.
8. Permit application of a retraction force from one hundred fifty to two hundred grams.

The design presented here comes reasonably close to satisfying most of the above requirements. If a shallow reflex causes tissue interference, the standard design length of both the retraction spring and the rigid arm can be shortened by placing a "v" bend in the straight portion. The spring wire has a round cross section which does not provide the lower deflection rate of flat wire (.010 x .020 was not available at the time) but the round wire presents less fabrication difficulties. The design is such that adjustment to bring the force up to level after three to six weeks of application is easy to accomplish. The type of lock used permits easy application, adjustment and removal of the spring. When the appliance has served its purpose, the rigid arm can be broken from the cuspid band at the point where its cross section is twisted near the spot weld.

Fabrication

The appliance shown was fabricated in groups of from six to twelve pairs at a time. The rigid arms were also prefabricated and assemblies with brackets, bands, and staples were prepared in advance. The bands were formed on indirect dies in the laboratory. The rigid arm was adjusted to clear the soft tissue at the time the band was checked in the mouth.

The spring was made of .018 inch diameter wire which was soldered to the surface of the head of the male portion of the large Gurin lock. A single coil was formed around the head of the lock and the end loop formed to gain the proper length of spring. The rigid arm was fabricated from .015 x .028 rectangular wire. The configuration of the assembly is clearly shown in Figures 1 and 2.

Clinical Application

Upper and lower cuspid retraction was started in about twenty cases. The appliance was placed with the first levelling wire. Intraoral x-rays and photographs were taken prior to the start, during progress and when the cuspid retraction appliance was removed. The data presented here are representative and cover two of the cases recorded. Soft tissue interference prevented the use of this appliance in approximately ten per cent of the cases. Most of these situations occurred in the lower arch where a shallow reflex or oblique tissue attachment would contact the end of the rigid arm and cause ulceration. Archwire engagement in the cuspid bracket was avoided by placing an .010 ligature to cross in the slot.

Case A shown in Figures 3 and 4 is

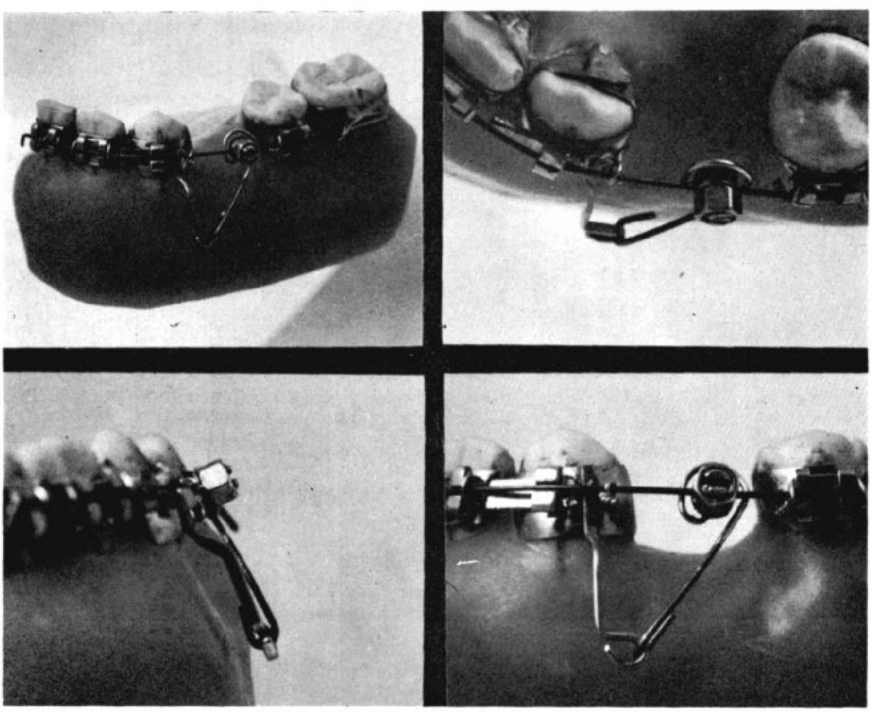

Fig. 2 Model of Appliance

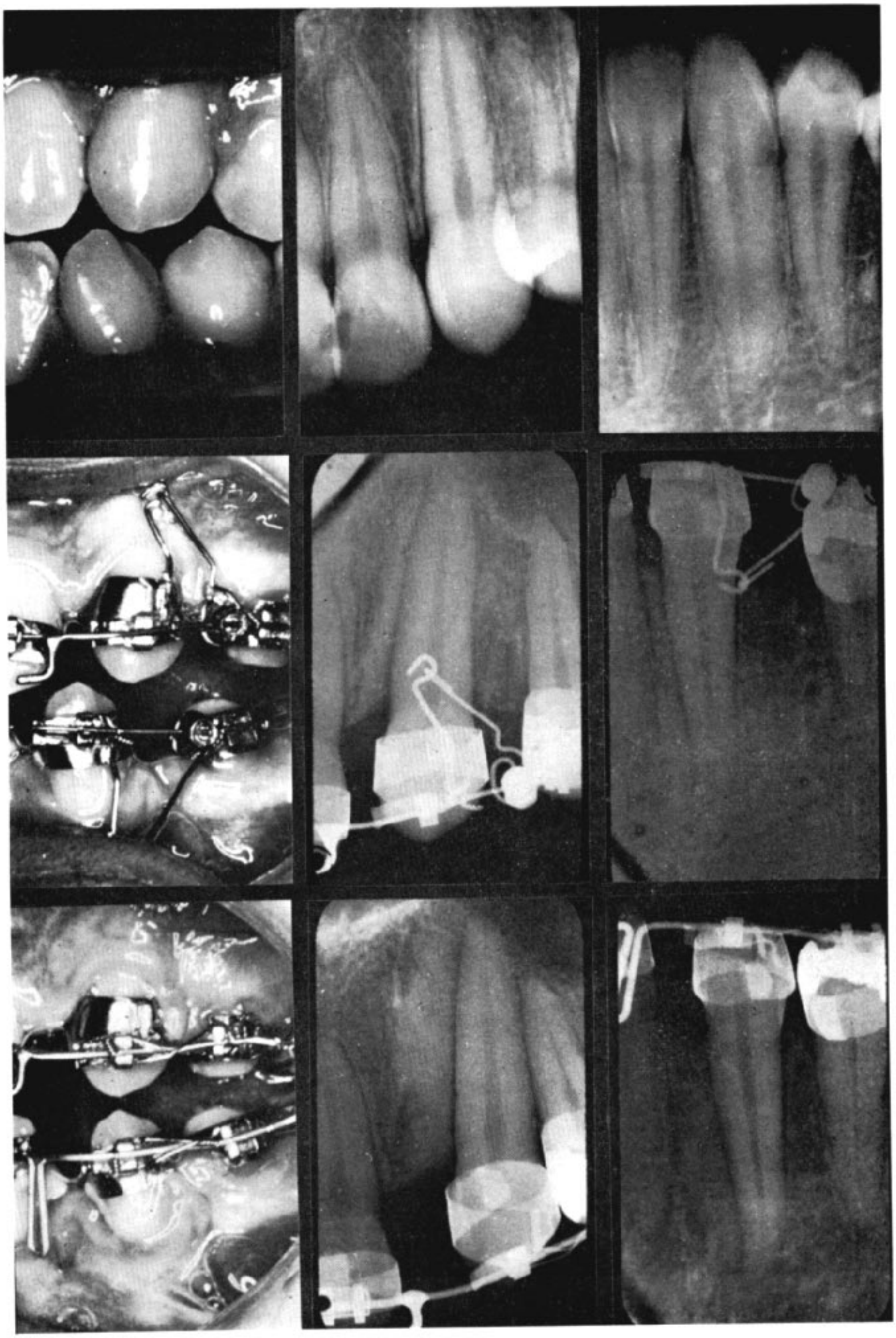

Fig. 3 Case A — left

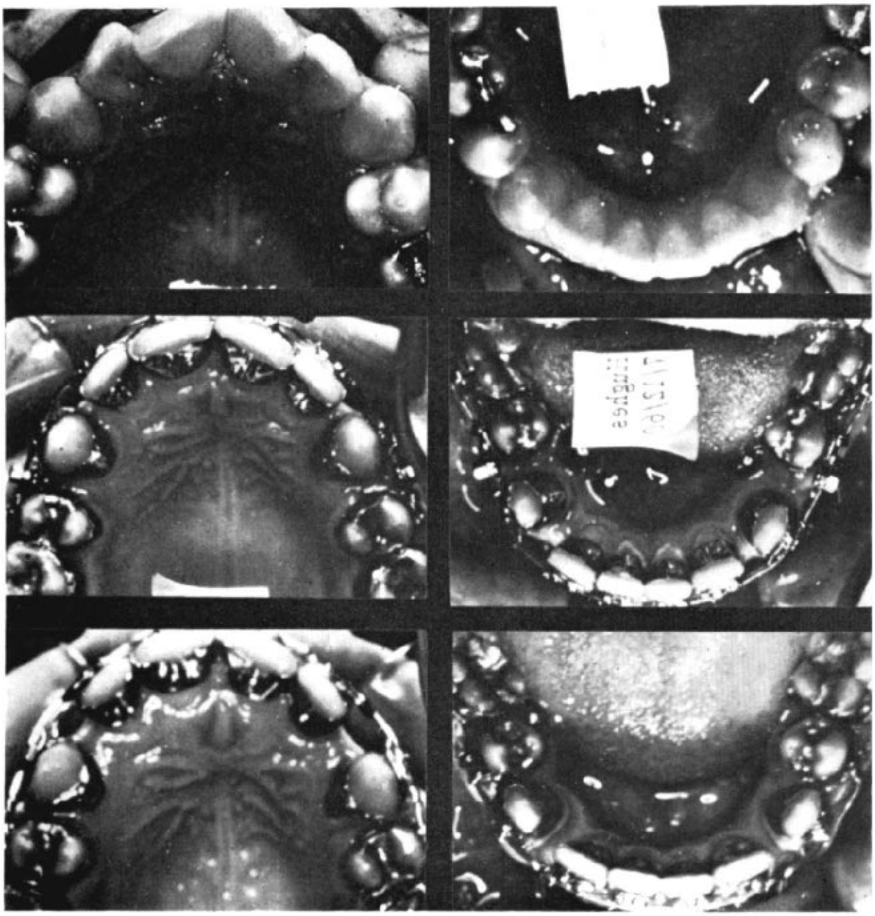

Fig. 4 Case A — occlusal

one in which all four cuspids were retracted by the cuspid retraction appliance. The upper row of pictures in each figure indicates the cuspid position before first bicuspid extraction and banding. The middle row of photographs are progress records taken during cuspid retraction. The bottom row are records taken at the time the cuspid retraction device was removed. Note that the cuspids had exceedingly long roots and that the point of force application was not at the ideal place as described above. Root movement of the upper cuspids was effective even to the point of overtreatment. Root movement of the lower cuspids, however, was not as effective. This can be attributed to the fact that the friction at the bracket area was more consistent on the upper cuspids than the lowers. This would be expected since the forces of mastication would create more disturbance on the lower archwire than the upper. It is likely that a state of static friction more often existed at the upper brackets while the lowers were more frequently in a state of sliding friction. Note in the occlusal views that good control of cuspid rotation was maintained throughout the procedure.

Case B shown in Figures 5 and 6 was

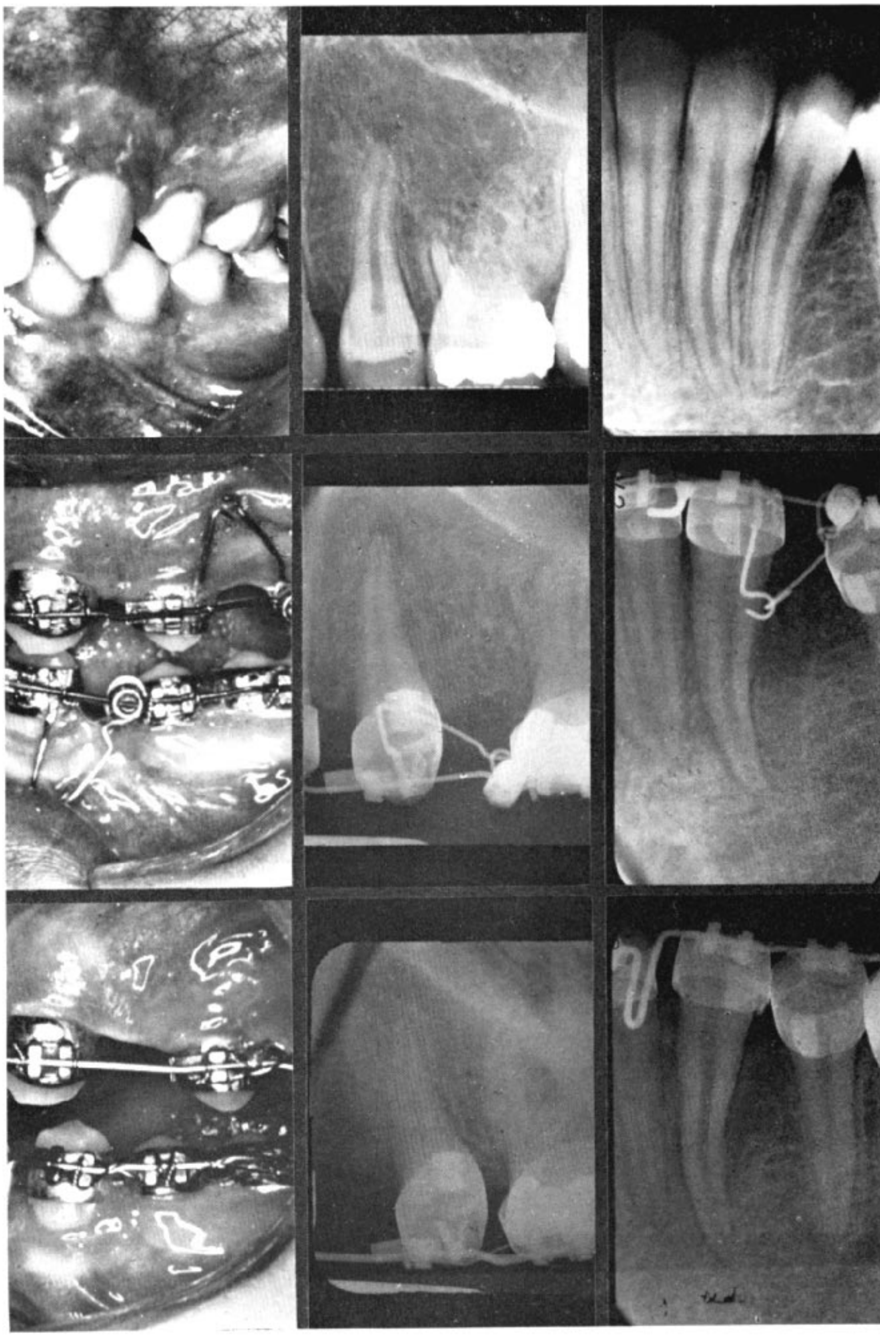

Fig. 5 Case B — left

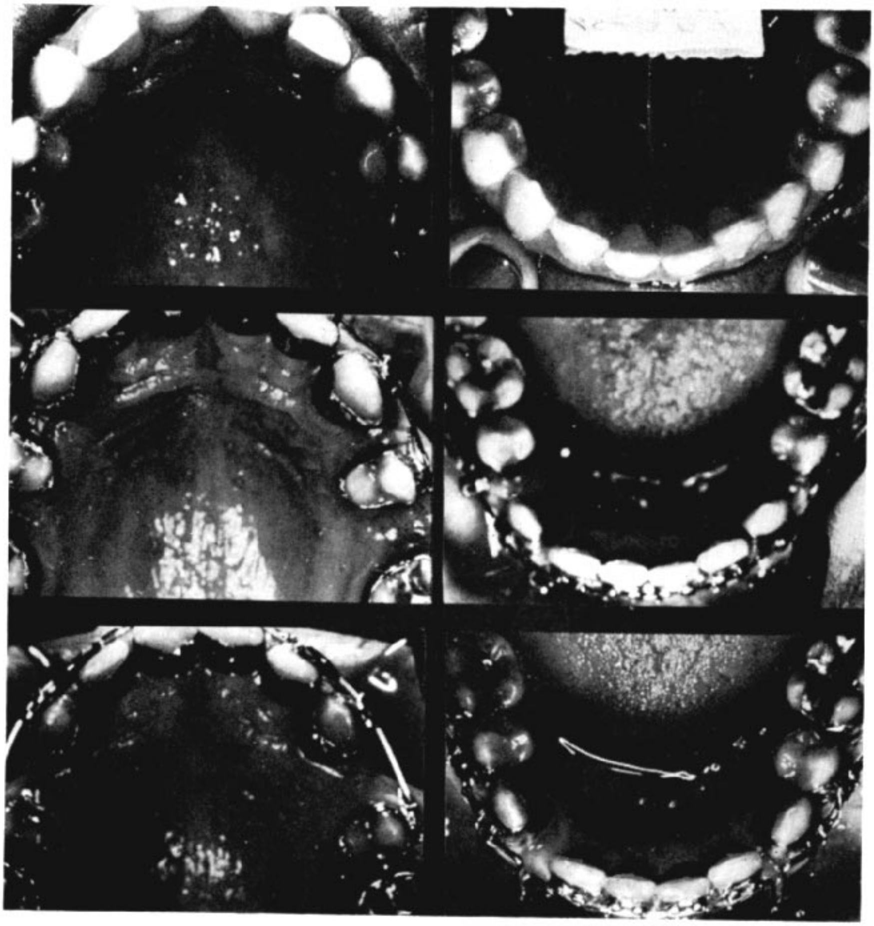

Fig. 6 Case B — occlusal

one of the few where the cuspid retraction device was applied to first bicuspids. In this case upper second bicuspids were congenitally missing and the first bicuspids were moved to the distal to take the place of the extracted second deciduous molars. Use of this device for bicuspid retraction proved to be very effective.

In all of the cases studied little or no cuspid root resorption was observed. Reitan has indicated favorable tissue behavior during translatory movement of teeth as against tipping of teeth. This study confirms his conclusions.

The time required to accomplish cuspid retraction varied considerably from cuspid to cuspid and patient to patient. Data of this type with many variables involved do not lend themselves to statistical analysis. The time for retraction varied from five to twelve months after placing the first archwire with the retraction device. Over fifteen per cent of the cuspids were retracted in five months. Fifty per cent of the cuspids were retracted in seven months. The average time for cuspid retraction was almost eight months. I present the figures with a word of caution since I believe the performance of this appliance will improve as the operator be-comes more experienced in its use. After reviewing my own cases I find that most of those which took over nine months were cases where excessive root movement was accomplished which, in turn, inhibited the distal movement of the crown.

Perhaps one of the most important advantages of this device is the fact that it can be applied when the first levelling arch is placed. The face bow and light Class III elastics may be used to minimize mesial movement of the buccal segments. Several cases were checked at the end of three or four months of cuspid retraction without headcap or elastics and the amount of mesial movement of first permanent molars could not be measured.

Conclusions

1. The problem of cuspid retraction was recognized as an awkward phase of orthodontic treatment because most techniques apply procedures of crown tipping and subsequent root movement. This approach introduces other problems which interfere with subsequent treatment procedures.

2. The theoretical mechanics of applying forces to result in translatory cuspid retraction were examined and a system of forces established.

3. Design requirements for a translatory cuspid retraction appliance were outlined.

4. The appliance fabrication was described and demonstrated.

5. The clinical application of this method of cuspid retraction was applied over a three year period. Cuspid retraction by translation was accomplished. The device and its method of application proved practical.

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